CONFERENCE OF THE COMMITTEE ON DISARMAMENT

CCD/344
24 August 1971
Original: ENGLISH

JAPAN

Working paper containing remarks of Prof. Shunichi Yamada, the University of Tokyo, concerning the question of verification on the prohibition of chemical weapons, presented at the informal meeting on 7 July 1971

The question of verification of compliance with the prohibition of chemical weapons is considered to be extremely difficult because of the close interrelationship between the production of such weapons and industry for peaceful purposes and also because such production requires only comparatively simple techniques. We have made a careful study with a view to finding technical methods which would enable us to conduct more or less effective verification, which, as we have just mentioned, will involve many complexities, and our past study has made it possible for us to come up with some suggestions in this regard. We believe that a suitable combination of these suggestions, though it may be far from perfect as a method of verification of chemical weapons, will provide us with some clue in our present efforts. This paper tries to examine in more detail our past suggestions and attempt to present them in somewhat more precise manner.

Since the question of verification of chemical weapons in general is much too wide a subject, we have concentrated on the question of verification specifically relating to the production of nerve agents, which are, of course, organophosphorus compounds. Organophosphorus compounds are widely used in industry for peaceful purposes in the production of pesticides and it was from the research in pesticides that the discovery of nerve agents originated. However, unlike in the field of pesticides where efforts have been made to lower their toxic effects on mammals, the development efforts in the field of nerve agents have been directed towards increasing their toxic effect. At the present time the toxic level of nerve agents is reported to be between 1,000 and 10,000 times greater than that of pesticides. It is to be noted that the difference in chemical structure between nerve agents and pesticides lies in the fact that, while sarin, soman, V agents and all other new types of nerve agents, with a few exceptions, contain methyl-phosphorus bonds, no chemical compounds with such bonds are used as pesticides. Therefore, should we be able to establish a highly sensitive method of microanalyzing a methyl-phosphorus bond, it would greatly facilitate the detection of nerve agents.

GE.71-19169
71-18655

Last summer we submitted to this Committee a working paper (CCD/301) in which we stated: "If an emission electrode for a flame thermionic detector is attached to the nozzle of a flame ionization detector in gaschromatography, a high sensitivity will be shown by phosphorus compounds and the minimum amount detectable will be 1×10^{-12} gram." We noted further that, by using this method, it would be possible to detect and identify such known nerve agents as sarin, soman and V agents or their decomposed products which might exist in very small quantities in liquid wastes from the chemical plant concerned, the soil and dust in and around the producing plant, or on the production equipment or the workers' clothes, by checking their retention times.

Generally speaking, nerve agents are methylphosphonic ester halogenides and they are converted to methylphosphonic acid by hydrolysis, with their methyl-phosphorus bond remaining unsevered. If, therefore, we apply the method of gaschromatography mentioned above to such methylphosphonic acid itself or to its methyl or ethyl ester, which has a low boiling point, we might be able to analyse them both qualitatively and quantitatively. Since this method would enable us to verify the presence or absence of known nerve agents as well as those derivatives which have methyl-phosphorus bonds and which cannot be used for purposes other than the production of nerve agents, it would be a useful means of verification of nerve agents, irrespective of whether or not they are already known.

It will hardly be necessary to add that further detailed study of various factors affecting hydrolysis or conditions in applying gaschromatography such as the type of columns to be used, temperature, sensitivity of the instruments, etc., would be required.

If we could establish the method of microanalysis of chemical compounds with a methyl-phosphorus bond, it would be possible to verify whether or not nerve agents are being produced by checking liquid wastes from the suspected plant or even from the atmosphere or river water at a considerable distance from the plant. It goes without saying that the same method, if applied in the case of an investigation with direct access to the suspected plant, would be even more effective. Although we have at present no such data based on actual experiments, we believe that the method we have suggested can be a possible means of verification and if we could visit, together with representatives from other countries, facilities where nerve agents are actually handled and investigate them, it would provide us with valuable information to prove the effectiveness of our concept.

We put forward another suggestion in the same working paper dealing with necessary data which would contribute indirectly, if not directly, to the detection of production of nerve agents. To that end, we suggested the establishment of a system under which countries would report on the statistics for certain phosphorus compounds, giving the

amounts produced, exported and imported and figures for consumption for different purposes. If such a system worked properly, it would contribute to the prevention of the use of those substances for the production of nerve agents. We should now like to attempt to explain this approach in rather more detail.

Nerve agents are organo phosphorus compounds and their manufacture requires phosphorus compounds as the principal raw material as well as many kinds of auxiliary materials or solvents, and the lack of any of them would make production impossible. However, since the auxiliary materials or solvents used in the production of phosphorus compounds are also widely used in the production of many other industrial goods and it would be extremely difficult to trace the flow of these materials, it would be practical to leave them aside for the moment and focus our attention on the flow of the principal raw material, that is, phosphorus compounds. Thus, if we check statistically the amount of production and consumption of yellow phosphorus, which is the starting material, and other various important intermediates in the production of nerve agents, we should be able to ascertain whether or not chemical compounds of the organophosphorus family are being used for the production of nerve agents. Although there are various methods for the production of such agents, which are already known or could conceivable be developed, it would suffice for us to concentrate on some of them from the viewpoint of the possibility of industrial mass production. Important intermediates which are common in those several practicable methods are yellow phosphorus, phosphorus trichloride, phosphorus oxychloride, phosphorus pentachloride and phosphorus pentasulfide, which are all inorganic phosphorus compounds, as well as such organophosphorus compounds as dimethyl or diethyl phosphite, trimethyl or triethyl phosphite and methylphosphonic dichloride or difluoride. With the exceptions of methylphosphonic dihalogenides, those compounds are all used in great quantities as materials or solvents in the manufacturing of agricultural chemicals, pharmaceuticals, perfumes, dyestuffs, vinyl chloride stabilizer or plasticizer. Methylphosphonic acid dichloride or difluoride contains a methyl-phosphorus bond, and belongs to a special group of chemical compounds. It is also considered to be an important final intermediate in the production process of nerve agents and is reported as possessing itself a high toxic effect. Although it is reported that it can be used as a material for the production of polymers containing phosphorus, we do not have any detailed information on it.

In Japan, the statistics on the amounts of the production and consumption of the inorganic phosphorus compounds mentioned above are systematized and made public. Recently a survey has been conducted on the flow of those intermediate materials in Japan. For the information of each delegation, the tables on the amount of consumption of

phosphorus trichloride and phosphorus oxychloride in Japan are attached to this working paper. However, there are not sufficient statistics on organophosphorus compounds other than agricultural chemicals. Furthermore, methylphosphonic dihalogenides, which have no peaceful uses, are, of course, not industrially produced or used in Japan. Accordingly, we believe that, if countries do their best to gather reliable statistics in a more systematic way on the phosphorus compounds and clarify the flow of such compounds, it would make it possible to some extent to check the possibility of their being diverted to the production of nerve agents. Considering the possibility of other methods of manufacturing nerve agents and of the isolation of intermediates, those chemical compounds which we have dealt with might not be the best ones as check points. Also, the question of the relationship between the extent of statistical errors and the amounts of intermediates required for the production of nerve agents might throw some doubts on the usefulness of preparing such statistics. However, if we try to minimize the weakness in the system for the preparation of statistics, and countries concerned are persuaded to make them public, it would result in a situation favouring the prevention of the production of nerve agents and would help to build up mutual confidence among states.

We should like now to deal with a matter which is not necessarily related to any concrete means of verification but designed to prevent the secret development of or research on new types of highly toxic chemical weapons in the future. Last summer, in this Committee, we proposed that the existing chemical compounds with toxic effects above a certain level should be listed as items to be reported upon and that a system should be established so that, when new chemical substances whose toxic effects equal] or exceed that level were discovered, they might be tested by an appropriate international research institute and, if they were found to have toxic effects equal to or above that level, this would be announced. We further suggested as the toxic level to be used as the criterion for this purpose a lethal dose (LD_{50}) of 0.5 milligramme per kilogramme of body weight by hypodermic injection. The basis for this suggestion is that we can safely assume that no chemical substance with a toxic effect equal to or above that level can be used for peaceful purposes.

There are more than ten kinds of chemical compounds with toxic effects equal to or exceeding the suggested level: namely, tabun, soman, sarin, VX, a few organophosphorus compounds which were mentioned in our working paper submitted last summer (CCD/301) and in the Netherlands working paper submitted this spring (CCD/320), such toxins as

botulinus toxin and tetrodotoxin, alkaloids such as aconitine and plant heart poisons such as scillaren. If these substances need to be manufactured as pharmaceuticals or for other peaceful purposes, we would be able to agree to report on the purpose, amount and place of the production.

The criterion lethal dose (LD_{50}) of 0.5 milligramme per kilogramme of body weight would be based on hypodermic injection, the method by which most of our available data have been obtained. However, there still exist such questions as whether the criterion should be based on the same route of absorption as in the case of use as a chemical weapon, that is, inhalation or percutaneous absorption, and whether we should use a uniform method of testing on animals, specifying the kind of animals to be used, their weight and number. On these problems we should like to hear the opinion of pharmacology experts. It would also be desirable to hold further discussions on the question of choosing an appropriate international body which would carry out authoritative tests in this regard.

Table 1

Amount of Consumption of Phosphorus Trichloride (PCl_3) by Purpose in Japan
(tons)

Purpose \ Year	1965	1966	1967	1968	1969	1970 (est.)
Agricultural Chemicals	785 (32.4)	1.182 (40.3)	1.761 (46.0)	2.343 (51.2)	2.714 (53.9)	3.120 (55.7)
Vinyl Chloride Stabilizer	689 (38.4)	877 (29.9)	1.112 (29.0)	1.063 (23.1)	1.229 (24.4)	1.280 (22.9)
Dyestuffs	622 (25.7)	507 (17.3)	677 (17.7)	801 (17.5)	642 (12.7)	493 (8.8)
Pharmaceuticals	77 (3.2)	115 (4.0)	80 (3.1)	122 (2.7)	99 (2.0)	175 (3.1)
Others	249 (10.3)	250 (8.5)	200 (5.2)	250 (5.5)	353 (7.0)	532 (9.5)
Total	2.422 (100)	2.931 (100)	3.830 (100)	4.579 (100)	5.037 (100)	5.600 (100)

Percentage values are given in parentheses.

Table 2

Amount of Consumption of Phosphorus Oxychloride ($POCl_3$) by Purpose in Japan
(tons)

Purpose \ Year	1965	1966	1967	1968	1969	1970 (est.)
Plasticizers	1.263 (41.6)	1.460 (42.2)	1.963 (47.6)	2.376 (48.1)	2.498 (48.5)	2.882 (53.9)
Pharmaceuticals	1.037 (34.2)	800 (23.1)	790 (19.2)	1.017 (20.6)	1.288 (25.0)	1.164 (21.8)
Perfumes	49 (1.6)	45 (1.3)	97 (2.4)	141 (2.9)	134 (2.6)	107 (2.0)
Others	684 (22.6)	1.157 (33.4)	1.270 (30.8)	1.405 (28.4)	1.233 (23.9)	1.199 (22.4)
Total	3.033 (100)	3.462 (100)	4.120 (100)	4.939 (100)	5.153 (100)	5.351 (100)

Percentage values are given in parentheses.